Final Report: Evaluation of fungicide programs for management of Botrytis bunch rot of grapes: 2017 field trials

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Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

Summary

Bunch rot of grapes caused by *Botrytis cinerea* is a fast-growing pathogen infecting numerous crops of commercial value. Bunch rot leads to a reduction in the yield and quality of table, raisin, and wine grapes, with high economic losses in some locations or years (Flaherty et al. 1992). Botrytis overwinters as sclerotia in mummified berries on the vine or ground or on dormant canes. The disease may first appear as shoot blight following frequent spring rains; flowers can become infected during bloom (Bulit and Dubos 1988). In infected fruits, disease symptoms are latent until late in the season. As sugar concentration increases in the berry, the fungus resumes growth and infects the entire fruit, often resulting in berry splitting and sporulation (Fig. 3) on the fruit surface (Flaherty et al. 1992). Free water is a requirement for the pathogen, and favorable conditions include humidity's exceeding 90% and temperatures between 15-27° (Bulit and Dubos 1988, Gubler et al. 2008, Steel et al., 2011). Along with leaf removal and other cultural controls, good spray coverage with a synthetic fungicide is currently the most effective form of disease management.

We examined the efficacy of 26 fungicide treatment programs (Table 2 and 3) for control of Botrytis bunch rot in Chenin blanc grapes on the research station at the Plant Pathology Department, University of California, Davis in 2017. Materials included synthetic, biological, and organic treatments.

Materials and Methods

A. Experimental Design

The field trial was conducted using completely randomized design, with plot consisting of 2 adjacent vines (11 ft row spacing and 7 ft vine spacing). Each treatment consisted of 4 replicates (0.014 acres). Fungicides were applied with backpack sprayers. Unless instructed otherwise (see Table 3 for application history), three applications were made during the growing season: April 17 (bloom), Jun 7 (pre-close), July 10 (veraison). Each application was made in 150 gallons/acre of water (2.1 gallons/treatment). Other pesticides were applied between bloom and harvest by the vineyard manager for control of powdery mildew.

Table 1: Experimental design: Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

Experimental design	Complete randomized design with 4 replicates.
Experimental unit	2 adjacent vines = 1 plot
Plot area	154 ft^2 (row spacing = 11 ft, vine spacing = 7 ft)

Area/treatment	616 ft^2 (4 reps x 2 vines = 1 treatment)	Area/treatment	0.014 acre/treatment
Volume water/acre	150 gallons = 2.1 gallons/4 reps		
Application method	STIHL SR 430 Backpack Sprayer		

B. Experimental Treatments

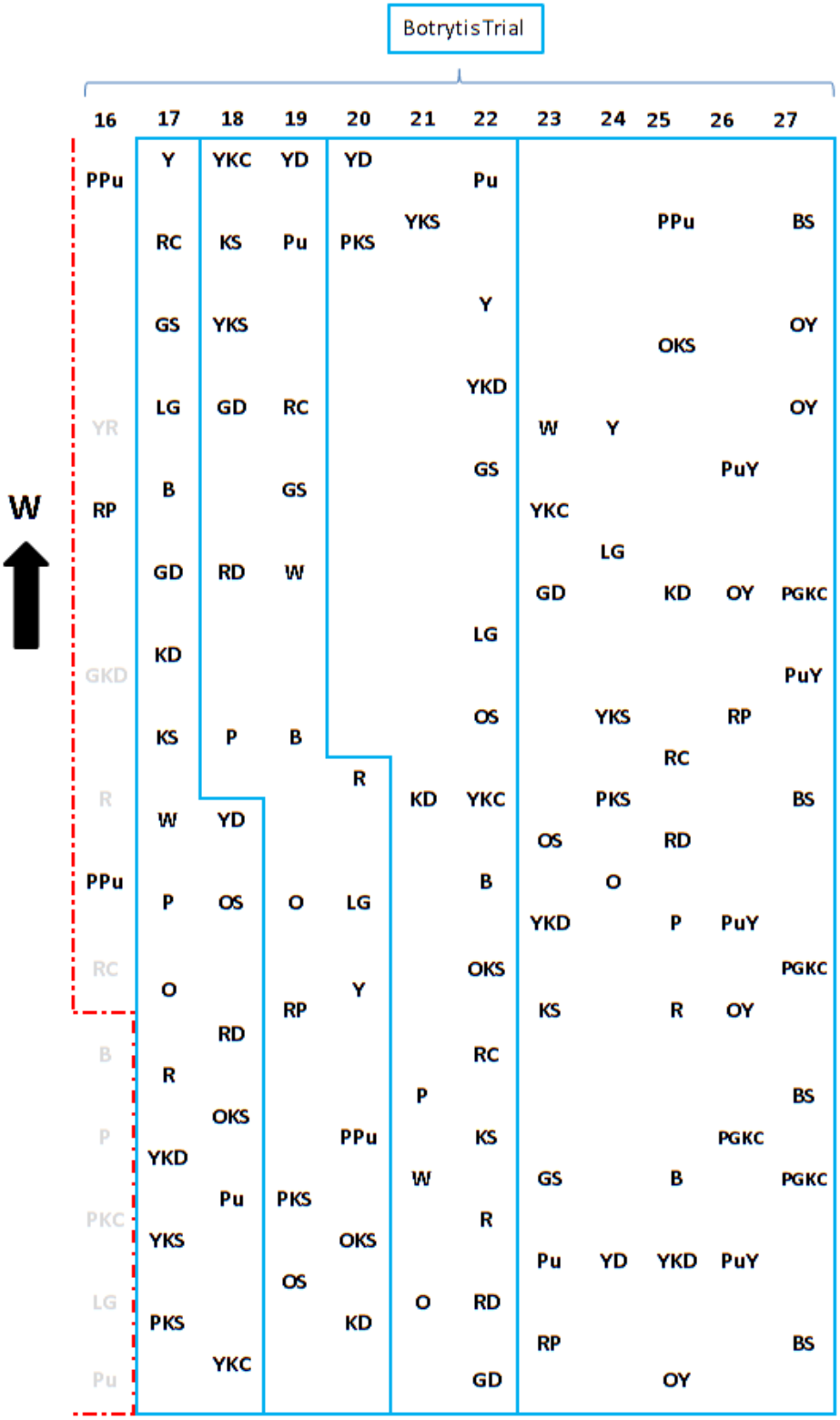
Table 2: Experimental fungicide treatments. "FP" = formulated product

Trt. No.	Flag	Treatment Name	Application rate (per acre)	FP/4Rep.	Timing
1	YD	SA-0650001 (SC)	54 fl oz	22.6 ml	A(pre-bloom/bloom) B(pre-close) C(ver.)
2	YKD	SA-0650001 (SC) + SA-0670001 (WP)	54 fl oz + 2.5 lb	22.6 ml + 16 g	A(pre-bloom/bloom) B(pre-close) C(ver.)
3	RC	SA-0650001 (SC) + Elevate 50WDG	54 fl oz + 1.0 lb	22.6 ml + 6.4 g	A(pre-bloom/bloom) B(pre-close) C(ver.)
4	PKS	Elevate 50WDG (Standard)	1.0 lb	6.4 g	A(pre-bloom/bloom) B(pre-close) C(ver.)
5	GS	Pristine	23 oz	9.2 g	A(pre-bloom/bloom) B(pre-close) C(ver.)
6	GD	Botector	8 oz	3.2 g	5-7-day schedule (start 10% bloom)
7	OS	Pyraziflumid SC + SylCoat	1.7 fl oz + 0.25% (v/v)	0.7 ml + 20.1 ml	A(pre-bloom/bloom) B(pre-close) C(ver.)
8	KS	Pyraziflumid SC + SylCoat	3.38 fl oz + 0.25% (v/v)	1.4 ml + 20.1 ml	A(pre-bloom/bloom) B(pre-close) C(ver.)
9	KD	#1: MBI-110AF5 #2: Switch #3: Luna Experience	#1: 2 qt #2: 14 oz #3: 8.6 fl oz	#1: 26.8 ml #2: 5.6 g #3: 3.6 ml	#1 - A (Full Bloom) #2 - B (Cluster Closure) #3 - C (Ver.)
10	YKC	#1: Switch #2: MBI-110AF5 #3: Luna Experience	#1: 14 oz #2: 2 qt #3: 8.6 fl oz	#1: 5.6 g #2: 26.8 ml #3: 3.6 ml	#1 - A (Full Bloom) #2 - B (Cluster Closure) #3 - C (Ver.)
11	P	#1: Switch #2: Luna Experience #3: MBI-110AF5	#1: 14 oz #2: 8.6 fl oz #3: 2 qt	#1: 5.6 g #2: 3.6 ml #3: 26.8 ml	#1 - A (Full Bloom) #2 - B (Cluster Closure) #3 - C (Ver.)

12	Y	MBI-110AF5	2 qt	26.8 ml	#1 - A (Full Bloom) #2 - B (Cluster Closure) #3 - C (Ver.) #4 - D (14 days after ver.)
13	Pu	#1: Luna Exp + SylCoat #2: Flint Extra + SylCoat #3: Scala + SylCoat	#1: 8.6 fl oz + 4 fl oz/100gal #2: 3.8 oz + 4 fl oz/100gal #3: 6.6 fl oz + 4 fl oz/100gal	#1: 3.6 ml + 2.5 ml #2: 1.5 g + 2.5 ml #3: 2.8 ml + 2.5 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
14	LG	#1: Luna Exp +SylCoat #2: Flint Extra + SylCoat #3: Serenade Opti + SylCoat	#1: 18 fl oz + 4 fl oz/100gal #2: 3.8 oz + 4 fl oz/100gal #3: 16 oz + 4 fl oz/100gal	#1: 7.5 ml + 2.5 ml #2: 1.5 g + 2.5 ml #3: 6.4 g + 2.5 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
15	B	Fracture	36.6 fl oz	15.3 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.) #4 - D (Ripening)
16	R	Luna Exp. 400 SC + SylCoat	8 fl oz + 0.125 % (v/v)	3.3 ml + 10.0 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
17	O	#1: Miravis Prime 3.33 SC + SylCoat #2: Elevate 50 WG + SylCoat #3: Switch 62.5 WG + SylCoat	#1: 13.5 fl oz + 0.125 % (v/v) #2: 1 Ib + 0.125 % (v/v) #3: 14.0 fl oz + 0.125 % (v/v)	#1: 5.6 ml + 10.0 ml #2: 6.4 g + 10.0 ml #3: 5.9 ml + 10.0 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
18	RD	Miravis Prime 3.33 SC + SylCoat	11.4 fl oz + 0.125 % (v/v)	4.8 ml + 10.0 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
19	OKS	Miravis Prime 3.33 SC + SylCoat	13.5 fl oz + 0.125 % (v/v)	5.6 ml + 10.0 ml	#1 - A(Bloom) #2 - B(Pre-Close) #3 - C(Ver.)
20	PuY	Zivion	250 ppm	2.0 ml	Bloom then 14 Days
21	BS	Zivion	500 ppm	4.0 ml	Bloom then 14 Days
22	PGKC	Zivion	1000 ppm	8.0 ml	Bloom then 14 Days
23	OY	Zivion + Raynox	500 ppm + 2 % (v/v)	4.0 ml + 160.6 ml	Bloom then 14 Days
24	YKS	Vintec	20.2 g	0.3 g	Bloom then Cluster Closure

25	PPu	Vintec	83 g	1.2 g	Bloom then Cluster Closure
26	RP	Vintec	161.9 g	2.3 g	Cluster Closure
27	W	Untreated	None	None	

C. Maps



Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

D. Application history

Table 3: Application History: Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

Treatment No.	Treatment	April	June	July
1	SA-0650001 (SC) 54 fl oz/A	x	x	x
2	SA-0650001 (SC) 54 fl oz/A + SA-0670001 (WP) 2.5 lb/A	x	x	x
3	SA-0650001 (SC) 54 fl oz/A + Elevate 50WDG 1.0 lb/A	x	x	x
4	Elevate 50WDG 1.0 lb/A (Standard)	x	x	x
5	Pristine 23 oz /A	x	x	x
6	Botector 8 oz/A	x x x	x x x x	x x
7	Pyraziflumid SC 1.7 fl oz + SylCoat 0.25% v/v	x	x	x
8	Pyraziflumid SC 3.38 fl oz + SylCoat 0.25% v/v	x	x	x
9	#1 - MBI-110AF5 2qt	x		
	#2 - Switch 14 oz		x	
	#3 - Luna Exp 8.6 fl oz			x
10	#1 - Switch 14 oz	x		
	#2 - MBI-110AF5 2qt		x	
	#3 - Luna Exp 8.6 fl oz			x
11	#1 - Switch 14 oz	x		
	#2 - Luna Exp 8.6 fl oz		x	
	#3 - MBI-110AF5 2qt			x
12	MBI-110AF5 2qt	x	x	x x
13	#1 - Luna Exp 8.6 oz + SylCoat 4 oz/100gal	x		
	#2 - Flint Extra 3.8 oz +SylCoat 4 oz/100gal		x	
	#3 - Scala 6.6 oz + SylCoat 4 oz/100gal			x

Treatm ent No.	Treatment	April																								June																														July																														
		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
14	#1 - Luna Exp 18 oz + SylCoat 4 oz/100gal									x																																																																											
	#2 - Flint Extra 3.8 oz + SylCoat 4 oz/100gal																																x																																																			
	#3 - Serenade Opti 16 oz + SylCoat 4 oz/100gal																																																																x																				
15	Fracture 36.6 fl oz									x																							x																														x														x							
16	#1-Luna Exp. 400 SC 8 fl oz + SylCoat 0.125 %v/v									x																							x																														x																					
17	#1- Miravis Prime 3.33 SC 13.5 fl oz + SylCoat 0.125 %v/v									x																																																																												
	#2 - Elevate 50 WG 1 Ib + SylCoat 0.125 %v/v																																x																																																			
	#3 - Switch 62.5 WG 14.0 fl oz + SylCoat 0.125 %v/v																																																														x																					
18	Miravis Prime 3.33 SC 11.4 fl oz + SylCoat 0.125 %v/v									x																							x																														x																					
19	Miravis Prime 3.33 SC 13.5 fl oz + SylCoat 0.125 %v/v									x																							x																														x																					
21	Zivion 250 ppm									x																x														x														x														x											x							
22	Zivion 500 ppm									x																x														x														x														x											x							
23	Zivion 1000 ppm									x																x														x														x														x											x							
24	Zivion 500 ppm + Raynox 2%v/v									x																x														x														x														x											x							
25	Vintec 50 g/ha (20.2g/A)									x																								x																																																		
26	Vintec 200 g/ha (83g/A)									x																								x																																																		
27	Vintec 400 g/ha (161.9g/A)																																	x																																																		

Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

E. Disease and Statistical Analysis

Disease was assessed on Sep 28, 2017. Botrytis bunch rot incidence and severity was assessed in each plot by evaluating twenty-five random clusters from the 2 vine plots. Incidence was defined as the number of clusters in a plot having some Botrytis bunch rot over the clean clusters in the same 2 vine plots. Severity was determined by estimating the percentage of berries in each cluster (Fig. 4). The severity value of all clusters was then averaged to give a plot-wide estimate of disease severity. Mean incidence and severity values for each treatment along with standard error were computed. Trial models were analyzed using the ANOVA Tests for data. Means comparisons were made using Fisher's LSD test at α=0.05.

E. Weather and Disease

Daily temperature and precipitation values were obtained from a CIMIS weather station in west Davis (CI006). The temperature data is shown in Figure 1. Fourteen precipitation events were recorded between April 6th through July 30th (Fig. 2).

Figure 1. Daily temperature data from Apr 1 to Jul 30 2017 from CIMIS station Davis, CA.

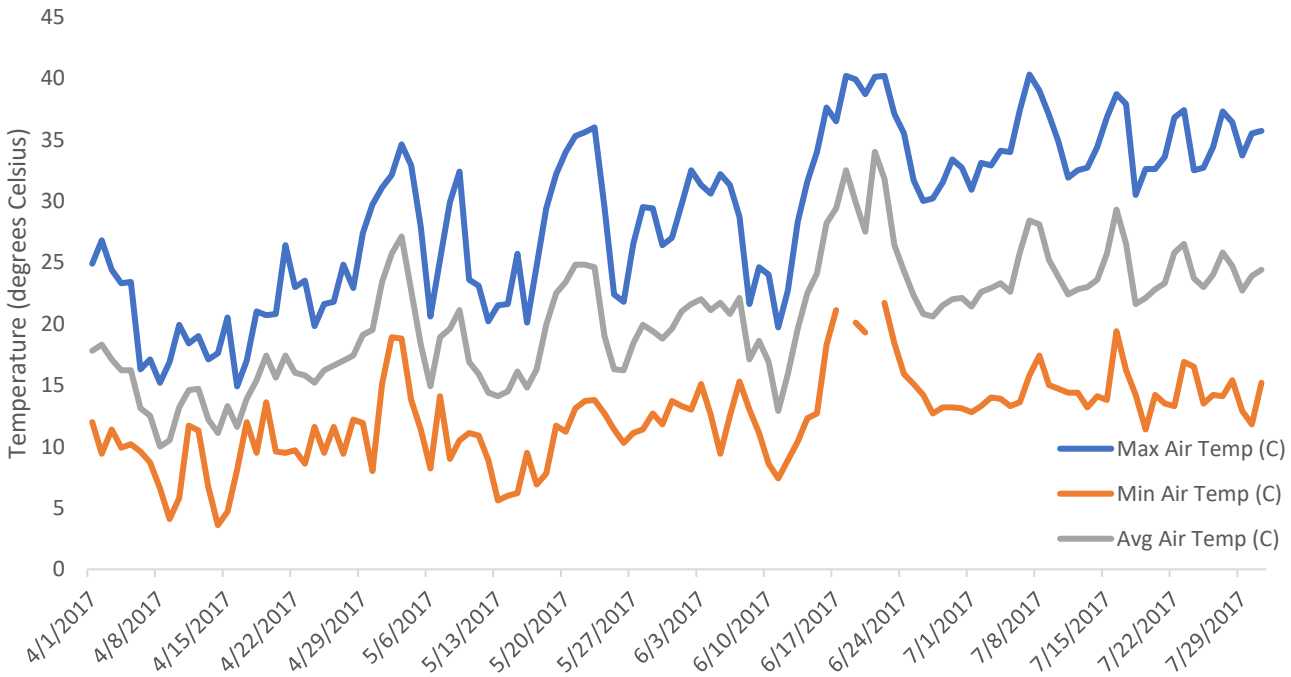
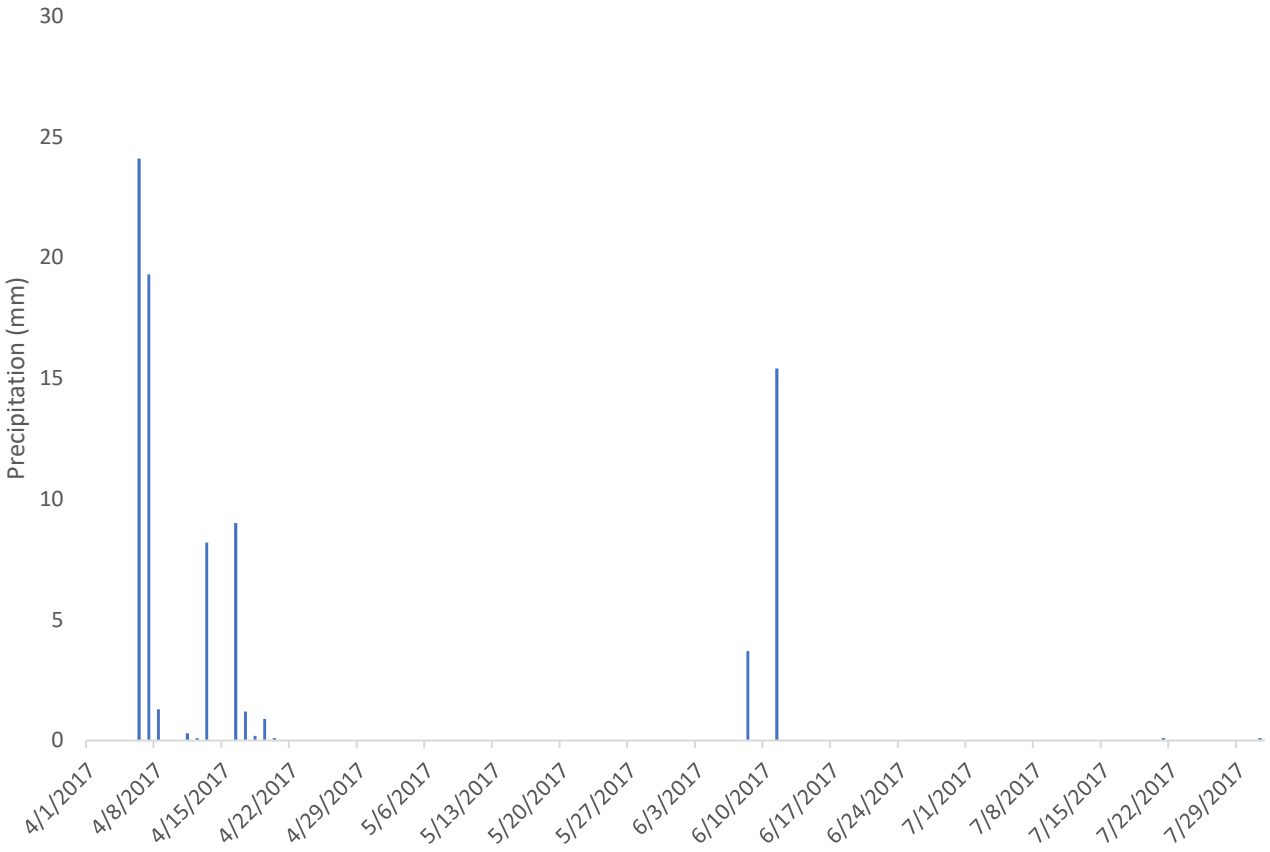


Figure 2. Daily precipitation data from Apr 1 to Jul 30 2017 from CIMIS station, Davis, CA.



Results

Table 4: Botrytis bunch rot incidence and severity. Product names are followed by rate (per acre). Treatment means followed by the same letter are not significantly different according to Fisher's LSD test at α=0.05; alt =alternated with. A = Bloom, B = Pre-Cluster Closure, C = Verasion, D = Ripening

Treatment	Mean Incidence (%)		Mean Severity (%)	
Zivion 1000 ppm Bloom then 14 Days	k	2.00	g	0.23
Miravis Prime 3.33 SC 13.5 fl oz + SylCoat 0.125 % (v/v) [**A, B, C**]	jk	4.00	fg	0.40
#1: Miravis Prime 3.33 SC 13.5 fl oz + SylCoat 0.125 % (v/v) #2: Elevate 50 WG 1 Ib + SylCoat 0.125 % (v/v) #3: Switch 62.5 WG 14.0 fl oz + SylCoat 0.125 % (v/v) [**A, B, C**]	jk	4.00	g	0.17
#1: MBI-110AF5 2 qt #2: Switch 14 oz #3: Luna Experience 8.6 fl oz [**A, B, C**]	ijk	5.00	defg	0.95
Pyraziflumid SC 3.38 fl oz + SylCoat 0.25% (v/v) [**A, B, C**]	hijk	6.00	g	0.37
Zivion 500 ppm Bloom then 14 Days	hijk	6.02	g	0.33
Pyraziflumid SC 1.7 fl oz + SylCoat 0.25% (v/v) [**A, B, C**]	ghijk	8.00	efg	0.81
Pristine 23 oz [**A, B, C**]	ghijk	8.00	bcdefg	1.31
MBI-110AF5 2 qt [**A, B, C, D**]	fghijk	9.00	fg	0.58
Luna Exp. 400 SC 8 fl oz + SylCoat 0.125 % (v/v) [**A, B, C**]	fghijk	9.00	g	0.37
#1: Switch 14 oz #2: Luna Experience 8.6 fl oz #3: MBI-110AF5 2 qt [**A, B, C**]	fghijk	9.00	efg	0.73
SA-0650001 (SC) 54 fl oz [**A, B, C**]	efghijk	10.00	abc	2.41
#1: Switch 14 oz #2: MBI-110AF5 2 qt #3: Luna Exp 8.6 fl oz [**A, B, C**]	efghij	11.00	defg	0.98
Vintec 161.9 g Cluster Closure	defghij	12.00	efg	0.88

#1: Luna Exp 8.6 fl oz + SylCoat 4 fl oz/100gal #2: Flint Extra 3.8 oz + SylCoat 4 fl oz/100gal #3: Scala 6.6 fl oz + SylCoat 4 fl oz/100gal [**A, B, C**]	defghij	12.00	efg	0.87
Vintec 83 g Bloom and Cluster Closure	defghij	12.00	abcdef	1.79
Vintec 20.2 g Bloom and Cluster Closure	defghi	13.00	efg	0.79
Miravis Prime 3.33 SC 11.4 fl oz + SylCoat 0.125 % (v/v) [**A, B, C**]	defghi	13.00	bcdefg	1.20
Elevate 50WDG (Standard) 1.0 lb [**A, B, C**]	defghi	13.00	bcdefg	1.21
Zivion 500 ppm + Raynox 2% (v/v) Bloom then 14 Days	defgh	14.00	cdefg	1.02
Zivion 250 ppm Bloom then 14 Days	cdefg	16.28	bcdefg	1.22
SA-0650001 (SC) 54 fl oz + Elevate 50WDG 1.0 lb [**A, B, C**]	cdef	17.00	ab	2.57
#1: Luna Exp 18 fl oz + SylCoat 4 fl oz/100gal #2: Flint Extra 3.8 oz + SylCoat 4 fl oz/100gal #3: Serenade Opti 16 oz + SylCoat 4 fl oz/100gal [**A, B, C**]	cde	18.00	abcdef	1.80
SA-0650001 (SC) 54 fl oz + SA-0670001 (WP) 2.5 lb [**A, B, C**]	bcd	20.00	a	3.17
Fracture 36.6 fl oz [**A, B, C, D**]	bc	23.00	abcde	2.05
Botector 8 oz 7-day schedule (start 10% bloom)	ab	28.00	abcd	2.34
Untreated	a	33.00	abcde	2.01

Acknowledgements

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References

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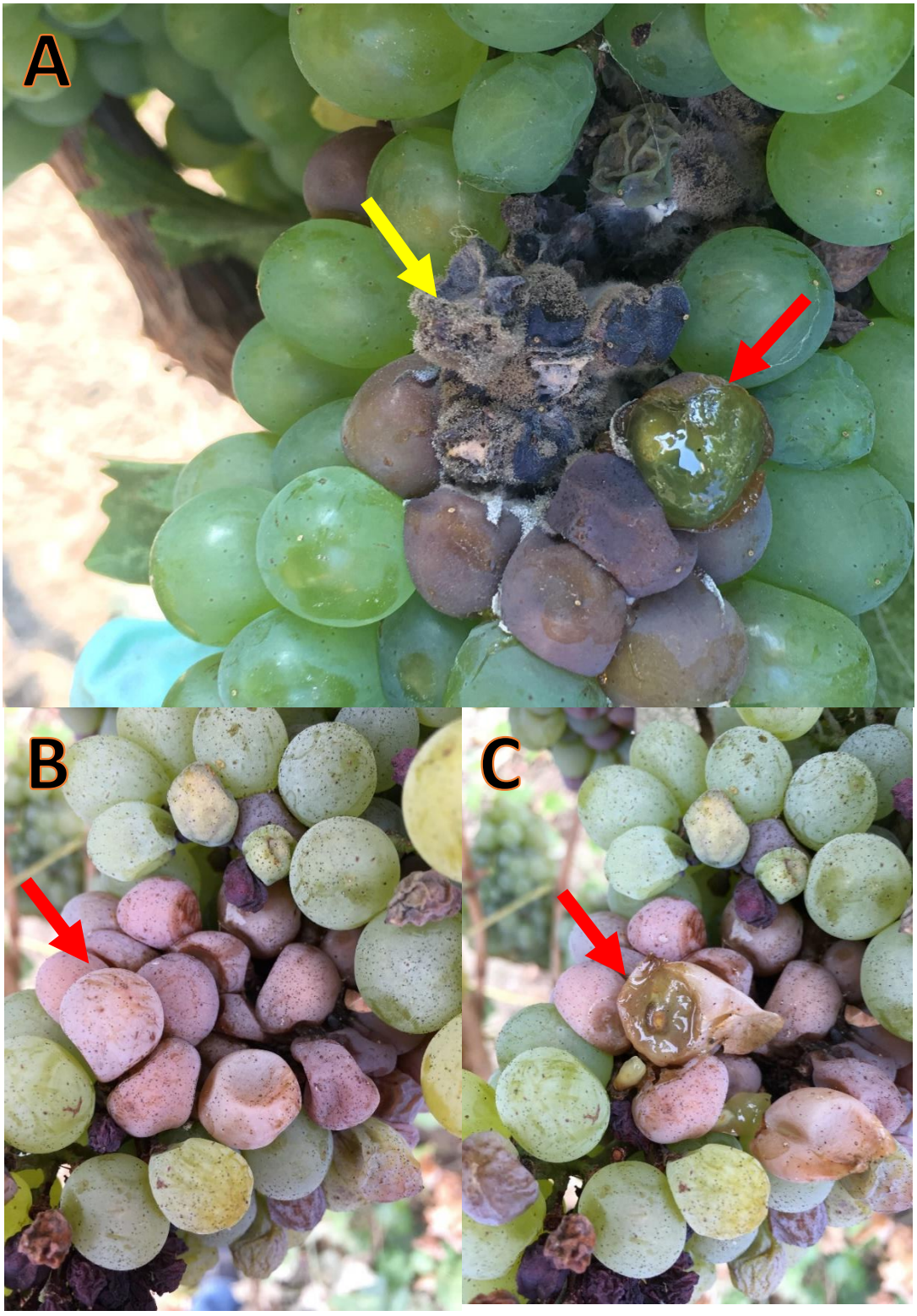
Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class (after Adaskaveg et al. 2008)
Botector	*Aureobasidium pullulans* strain DSM 14940 (40%) *Aureobasidium pullulans* strain DSM 14941 (40%)	Westbridge Agricultural Products	biological
Elevate 50WDG	Fenhexamid (50%)	Arysta LifeScience	DMI: SBI Class III
Flint Extra	trifloxystrobin (50%)	Bayer Crop Science	QoI (11)
Fracture	BLAD (20%)	FMC Corporation	plant extract
Luna Experience	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience	SDHI (7)/DMI-triazole (3)
MBI-110AF5	proprietary	N/A	proprietary
Miravis Prime 3.33 SC	proprietary	N/A	proprietary
Pristine	pyraclostrobin (12.8%) boscalid (25.2%)	BASF	SDHI (7)/QoI(11)
Pyraziflumid SC	proprietary	N/A	proprietary
Raynox	carnauba wax, organically modified clay	Valent BioSciences Corporation	sunburn protectant
SA-0650001 (SC)	proprietary	N/A	proprietary
SA-0670001 (WP)	proprietary	N/A	proprietary
Scala	Pyrimethanil (54.6%)	Bayer CropScience	AP (9)
Serenade Opti	*Bacillus subtilis* QST 713 (26%)	Bayer CropScience	biological
Switch	cyprodinil (37.5%), fludioxonil (25%)	Syngenta Crop Protection	anilinopyrimidine (9)/phenylpyrrole (12)
SylCoat	polyether-polymethylsiloxanecopolymer and Polyether (100%)	Wilbur-Ellis	adjuvant
Vintec	*Trichoderma atroviride* (TASC1)	Bi-PA	biological
Zivion™ M	Natamycin (10.34%)	DSM Food Specialties B.V.	unknown

Appendix sources: (1) Adaskaveg, et al. 2012. Efficacy and timing of fungicides, bactericides and biologicals for deciduous tree fruit, nut, strawberry, and vine crops 2012, available at http://ucanr.edu/sites/plp/files/146650.pdf. (2)

Gubler Lab field trials, available at http://plantpathology.ucdavis.edu/Cooperative_Extension/ (3) product-specific MSDS and/or labels.

Figure 3. A: Yellow arrow pointed at *Botrytis cinerea* sporulation on grape clusters. Red arrows pointing at infected barriers. When rubbed, the skin over these berries (B) cracks and slips freely (slip skin) and reveals the berry pulp (C).



Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.

Figure 4. A: Untreated control vs **B:** Treated (Elevate 50WDG (Standard) 1.0 lb) in Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis (Chenin blanc)

Grape Botrytis Bunch Rot field trial, 2017. Department of Plant Pathology, University of California, Davis.